Integrated Water Quality and Aquatic Communities Protocol – Wadeable Streams

Standard Operating Procedure (SOP) #3: Site Selection and GRTS

Draft Version 1.0

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

The SOP explains the procedure that is undertaken to develop the list of sites that the field crews are to sample for a particular field season. Rationale for choosing these methods are detailed in the protocol narrative and the reader is referred to the relevant section for more details.

Site Selection for Wadeable Streams

The procedure for developing a site list will only be necessary once, at the beginning of the project.

1. Available GIS shapefiles from the National Hydrography Dataset project are obtained from their web site (http://nhd.usgs.gov) or from the park GIS Specialist.
2. A list of suitable perennial streams is created based on the following criteria:
   a. The stream has sections <1000 m from an established trail or road.
   b. The slope of the surrounding terrain is <15%.
3. The judgment sites are removed from the available list of streams (detailed in narrative).
4. The remaining list is then used in GRTS (Generalized Random Tessellation Stratified) software, a plug-in for the statistical program "R," (Stevens and Olsen, 2004; below text and Figure 1). This application compiles a list of streams that when sampled in order of listing, provides a spatially balanced design.
5. Within each stream network, the GRTS algorithm is run on each individual stream chosen above, with the streams being divided into 500 m non-overlapping sample sections, where each section available for selection meets the above criteria of step 2.
6. The order of sections chosen in step 5 is then used to create the sampling list, with the "X point" (SOP #6: Site Arrival Tasks and Sample Reach Layout) being the middle of the section.
7. These sections are then sampled in order to obtain a spatially balanced sample within each stream.

Running GRTS in the statistical software package "R" requires knowledge of the program and programming that is beyond the scope of this protocol. However, background information and how to information is included here: http://www.epa.gov/nheerl/arm/designing/design_intro.htm

The code used in "R," once the library spsurvey is added, should look like this:

```
## Choosing Lakes: GRTS Example
path←"\\Stream_Monitoring\\Streams_GIS\\GRTS\\working\\"
library(spsurvey)

design  <- list(None=list(panel=c(Index=2, Time1=2, Time2=2, Time3=2,
Time4=2,Time5=2, Time6=2, Time7=2, Time8=2, Time9=2,Time10=2,
seltype="Equal", over=30))

grts(design, DesignID="Site", SiteBegin=1, type.frame="linear",
  src.frame="shapefile", in.shape=paste(path,"streams_select",sep=""),
sp.object=NULL, att.frame=NULL,
  id=NULL, xcoord=NULL, ycoord=NULL, stratum=NULL, mdcaty=NULL,
startlev=NULL,
  maxlev=11, maxtry=1000, shift.grid=TRUE, do.sample=TRUE,shapefile=TRUE,
  prjfilename=NULL, out.shape=paste(path,"LAVO_Stream_Sites1",sep=""))

design  <- list(None=list(panel=c(Index=2, Time1=2, Time2=2, Time3=2,
Time4=2,Time5=2, Time6=2, Time7=2, Time8=2, Time9=2,
Time10=2),seltype="Equal",over=30))

grts(design, DesignID="Site", SiteBegin=1, type.frame="linear",
  src.frame="shapefile", in.shape=paste(path,"streams_select",sep=""),
sp.object=NULL, att.frame=NULL,
  id=NULL, xcoord=NULL, ycoord=NULL, stratum=NULL, mdcaty=NULL,
startlev=NULL,
  maxlev=11, maxtry=1000, shift.grid=TRUE, do.sample=TRUE,shapefile=TRUE,
  prjfilename=NULL, out.shape=paste(path,"LAVO_Stream_Sites2",sep=""))
```

Specific purposes of the programming are detailed in Figure 1.

Literature Cited

Stevens, D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association **99**:262-278.

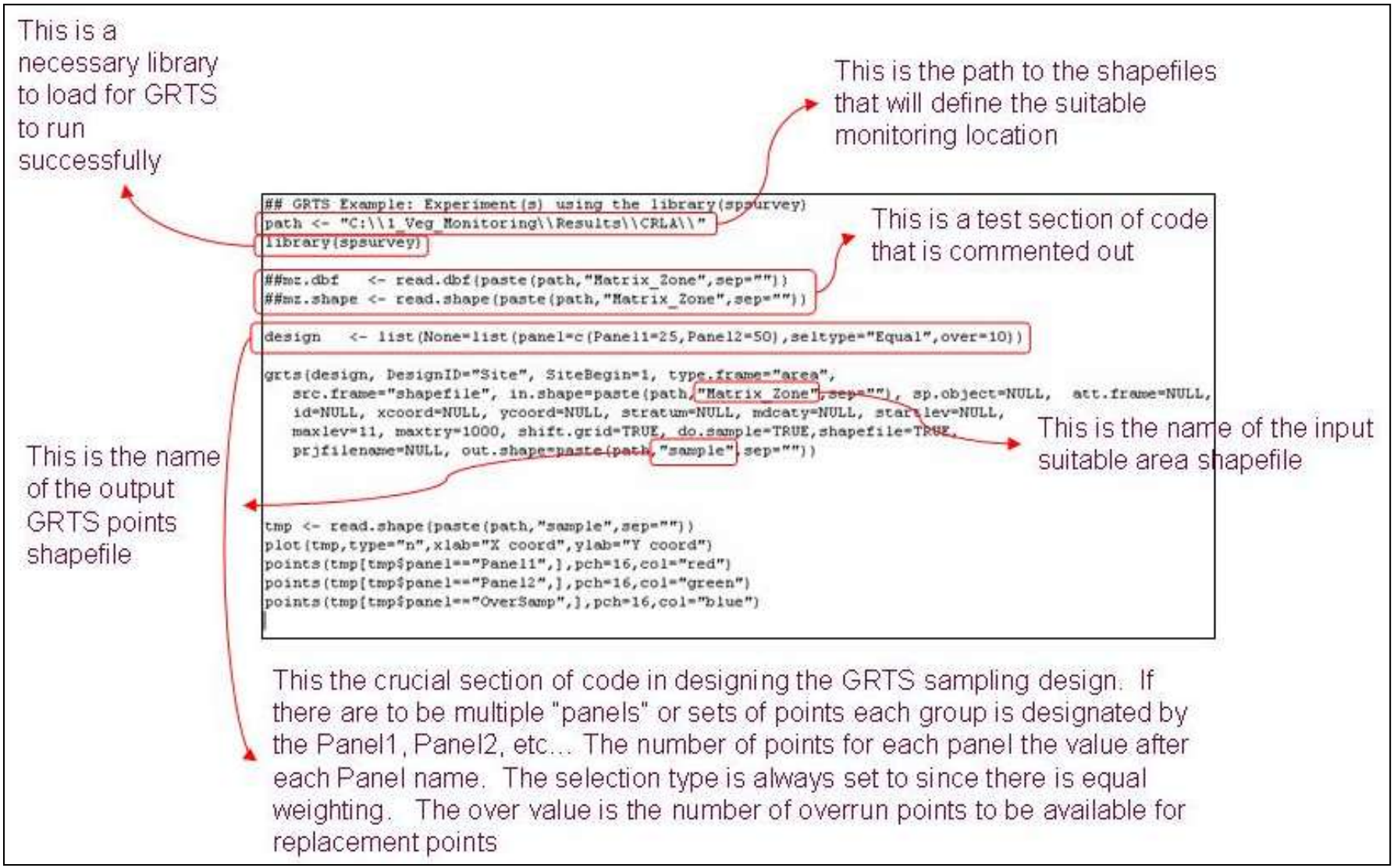

Figure 1. Layout of GRTS code to be run in the Software "R."